

Cal-THRIVES

Air Conditioning Systems

Description

An air conditioner (AC) cools your home by extracting indoor heat and expelling it outside. ACs improve indoor comfort and are usually required to keep your home at safe temperatures during heat waves. There are many types of air conditioners and several important considerations when choosing a new or replacement unit. ACs usually require electricity.

How AC Keeps You Cool and Comfortable

Residents living in a hot climate like Fresno, CA, can expect air conditioners to:

- Lower temperature and humidity inside your home
- Eliminate life-threatening overheating and keep you up to 18 °F (10 °C) cooler during extreme heat waves compared to no air conditioning.
- Keep you 5 °F (2.8 °C) cooler and much more comfortable than evaporative coolers during extreme heat waves.

SOURCE: Cal-THRIVES (Cal-THRIVES.lbl.gov), Berkeley Lab

Factors to Consider

- Whether or not you need an air conditioner.
- A high Equipment Energy Efficiency Ratio (EER) or Seasonal Efficiency Ratio (SEER) means a more efficient AC unit and lower electricity bill. EER is used to rate the efficiency of window and portable ACs as well as packaged terminal AC / packaged terminal heat pumps (PTAC/PTHPs). SEER is used to rate the efficiency of central ACs, air source heat pumps, and mini-split ACs and heat pumps.
- Equipment is sized appropriately to meet household comfort needs
- AC impacts such as noise and obstruction of window from a window AC
- Quality and reliability
- Ease of installation and maintenance
- Equipment price
- Installation (labor) cost



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Types of Air Conditioning

AC systems can be categorized in two groups: (1) larger centralized systems, which have a cooling unit and air handler that distributes cooled air to different rooms through ducts or plenum space; and (2) smaller, “room-scale” systems, which supply cooled air directly to the room, such as window ACs, ductless mini-split ACs, packaged terminal units, and portable AC units. Below we list types of AC sold today.

Central AC — A ducted system that cools many rooms in a home with a central evaporator and air handler indoors and a condenser outdoors.

Air source heat pump — Similar to central AC, it provides cooling in the summer but also heating in the winter, delivering cold or warm air to rooms through ducts.

Window AC — A non-ducted system that cools a room or an indoor space. It is a self-contained unit, installed in a window opening, with a section exposed to the outdoors.

Mini-split air conditioner/heat pump — These through-the-wall units join an indoor evaporator unit to an outdoor condenser unit with a pipe that carries refrigerant, and are typically used to cool or heat a single room. Some mini-splits provide only cooling, while others can also provide heating. A mini-split is more expensive to install than a window AC but can be much more energy efficient.

Packaged terminal air conditioner (PTAC) or packaged terminal heat pump (PTHP) — These self-contained (single unit) “through the wall” units can provide cooling only (PTAC) or both cooling and heating (PTHP). They are commonly found in hotels and motels.

Portable AC — A self-contained indoor unit (evaporator plus compressor) that sits on the floor and typically cools a single room, exhausting hot air from its compressor through a window-mounted hose. “Dual-hose” models that use outside air, rather than room air, in a sealed loop to cool the compressor are more efficient and won’t create a vacuum that can draw outside air through cracks below doors and around windows. Portable ACs are easy to install but are among the least energy-efficient choices.

Other than ACs, there are other types of powered cooling systems that may also provide thermal comfort, as follows:

Evaporative cooler — Not a mechanical air conditioner, this device cools the air by evaporating water. Evaporative coolers use little energy, but do require water. They work best in dry climates.

Fans — Portable fans and ceiling fans improve indoor comfort by circulating air, and let you raise the temperature set point of your air conditioner without sacrificing comfort. This can save on energy and lower utility bills during the cooling season.



Window AC



Portable AC



Mini-split heat pump
indoor unit



Mini-split heat pump
outdoor unit

Installation

Air conditioners can be professionally installed, or can be a do-it-yourself project for smaller self-contained units such as window ACs or portable ACs.

The cost to install an AC unit (equipment plus labor) varies widely for different AC options and depends on the existing AC in the home. For example, a new mini-split AC can be much more expensive to install than a portable AC, but costs less to operate because it's more energy-efficient.

The labor cost to replace an existing unit, such as an old window AC, with a newer, more efficient version of the same type is much lower than the labor cost to install a new central cooling system. Consult an HVAC installer if you need a new system to cool multiple rooms.

When to Consider Getting a New AC

In general, when an existing air conditioning system is no longer delivering enough cool air for comfort, and cannot be repaired cost effectively, a new AC may be the solution. This is especially critical if the lack of thermal comfort is adversely affecting productivity, health, and safety during extreme heat events. The typical lifetime of ACs used to cool a single room is 10–15 years. Central ACs and heat pumps, as well as mini-split ACs and heat pumps, have typical lifetimes of 15–20 years.

If your home does not have AC, consider adding an AC if you are uncomfortably warm during the summer even when using a fan, and have explored other energy efficiency measures for your home such as increased insulation, a radiant barrier in your attic, solar control window films, or cool roof/cool walls.

What to Look at When Your AC is Not Performing Well

Here are potential problems with an existing AC:

1. Not working as designed — needs service to repair compressor or fan

2. Not working as designed — needs service to fix refrigerant leak, typically in either the refrigerant line or evaporator (i.e., indoor heat exchanger) of a central or mini-split AC or heat pump






3. Not working as designed — need service to seal duct air leaks or add/replace duct insulation

4. Working as designed, but not suitable for today's climate (evaporative cooler or undersized mechanical AC)

5. Working as designed, but costs too much to operate because it's inefficient.

In some cases it is less expensive to repair old equipment or old ductwork than to purchase a new AC unit, but in some cases, a new AC unit might be best (e.g., #4 or #5 above)

When to Consider this Retrofit—Ownership

-  ☒ **Homeowner**
-  ☒ **Apartment/Home Renter — Long Term**
-  ☒ **Apartment/Home Renter — Short Term**
-  ☒ **Live in a Condo/Townhouse**
-  ☒ **Live in a Historical District**

What to Know or Look for When Selecting an AC

- Look for efficient units with the ENERGY STAR® label
- Having a professional install or remove an air conditioner is recommended in most cases
- Having a professional properly size the cooling capacity, particularly with central ACs and heat pumps, will prevent excessive oversizing. An oversized unit will cause the AC or heat pump to cycle frequently (i.e., turn on and off repeatedly) leading to inefficiency and higher energy use.





Ceiling fan



Portable fan



Smart thermostat



Attic fan

- If you are thinking of adding AC to your home, first consider lower-cost measures such as fans or solar control window films or permanent improvements to your home that will improve comfort throughout the year, such as improved attic insulation or wall insulation. Cool walls and cool roofs will also lower your cooling bills and are recommended when repainting or reroofing your home, respectively, as there is little to no added cost.
- Easier-to-install units such as portable ACs and window ACs are often less efficient and may cost more to run.
- Renters should check with owners before installing a new AC unit.
- Some weatherization programs will repair or replace your old air conditioner. Ask whether you are eligible during an energy efficiency audit or when speaking to a weatherization program contact.

Recommended Installer

- ☒ **Do it Yourself (for window ACs, portable ACs)**
- ☐ **Carpenter**
- ☒ **Manufacturer recommended installer**
- ☒ **Weatherization/utility program**

What to Consider When Operating an AC

- Use portable or ceiling fans in your home to reduce AC usage and save on electricity costs. Cooling provided by the air movement from fans allows you to increase the temperature set point on your AC and run your AC less. Fans can also help an undersized AC keep you cool.
- Consider enrolling in a demand response utility program (if available) that can lower your electricity rates in exchange for shifting or reducing your electricity usage about 10-15 times per year, e.g. PG&E SmartRate below.
- Any measure that can lower your home's need for AC demand will reduce electricity consumption, the strain on the electricity grid, and greenhouse gas emissions from electricity production. These measures include:
 - Raising the temperature set point on your thermostat in summer
 - Using portable fans and/or ceiling fans to raise your AC set point temperature without sacrificing comfort
 - Insulating your roof and walls
 - Sealing and insulating ducts to minimize loss of cool air
 - Installing other measures such as attic fans and radiant barriers in the attic
 - Implementing cooler surfaces on your home's exterior. Reflective exterior walls and roofs keep your home cooler in the sun (and for several hours after the sun sets). These are best implemented when you are repainting your home or re-roofing your roof, since there is little to no extra cost for choosing a cool version of a wall paint or roofing product.

Comparing Different Room AC Types, Fans, and Portable Evaporative Coolers

The table below provides some comparisons among several room AC types in addition to portable evaporative coolers and fans. This table is meant as a general guidance for new cooling systems and may not be applicable to all situations.

Considerations for various types of home cooling options	Energy Efficiency	Cooling capacity for extreme heat events	Noise level and other limitations	Quality and reliability	Ease of installation	Ease of maintenance	Equipment price	Installation costs	Operating costs
Mini-split AC or heat pump	●	●	●	●	◐	◐	◐	○	◐
Packaged terminal AC or heat pump	◐	●	◐	◐	◐	●	◐	○	◐
Portable AC	○	◐	○	○	●	●	●	●	○
Window AC	◐	●	◐	◐	◐	●	●	◐	◐
Evaporative coolers (portable)	●	○	◐	◐	●	●	●	●	●
Fans (portable fan, ceiling fan)	●	○	●	●	●	●	●	●	●

● Good to very good ◐ Fair ○ Not good to poor

Comparing Different Central AC Types and Evaporative Coolers

The table below provides some comparisons among various central AC types and central evaporative coolers to provide whole-home cooling. The equipment price, installation cost, and operating costs should not be compared directly to the table above since several room AC units would be needed to provide whole-home cooling. This table is meant as general guidance for new cooling systems and may not be applicable to all situations.

Considerations for various types of home cooling options	Energy Efficiency	Cooling capacity for extreme heat events	Noise level and other limitations	Quality and reliability	Ease of installation	Ease of maintenance	Equipment price	Installation costs	Operating costs
Air source heat pump	●	●	●	●	○	○	○	○	◐
Central AC	●	●	●	●	○	○	○	○	◐
Evaporative coolers (ducted)	●	○	●	◐	○	○	◐	◐	●

● Good to very good ◐ Fair ○ Not good to poor

References

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U.S. Department of Energy, Room Air Conditioners: <https://www.energy.gov/energysaver/room-air-conditioners>